Running Head: DCCS and Categorization

Dimensional Change Card Sort and Categorization:

Effect of Discrete Labels on Rule Processing in Children

A Senior Honors Thesis

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by

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Abstract

In the study of brain development, much research has focused on changes in executive function. According to the Cognitive Complexity and Control (CCC) Theory, the development of executive function can be understood through specific “age-related changes in the maximum complexity of rules children can produce and use when solving problems.” In order to evaluate these age-related changes, Philip Zelazo used the Dimensional Change Card Sort Task, which asks children ages 3-5 to sort a deck of 10 cards into two target piles based on two given sets of rules. The children are given a rule for sorting the first 5 cards of the deck; then a new rule is introduced for sorting the last 5 cards. The task evaluates the child’s ability to utilize executive control, inhibiting the first rule in favor of the second rule. Typically, children ages 3-4 continue to sort by the first rule, even when this response is no longer appropriate, while 4-5 year olds successfully complete the task. In traditional understandings of this task, children were asked to use rules focusing on dimensions, such as color, shape, and number. However, our manipulation of the DCCS will use rules formed on the basis of discrete categories, specifically asking children to separate between cat versus dog and toy versus pet. Through this manipulation of Zelazo’s original study, we hope to investigate the CCC theory’s reliance on dimensions to describe levels of complexity in executive function development.

Introduction

In developmental literature, researchers have devoted much of their studies to learning and concept processing in children. These studies have largely been concerned with the cognitive processes involved in learning and how these processes change over the course of normal development. One particular cognitive process associated with learning that receives a large amount of attention is executive function.

There are several approaches to executive function in psychological literature. For example, authors Denckla and Reiss (1997) view executive function as a "cognitive module consisting of effector output elements involving inhibition, working memory, and organisational strategies necessary to prepare a response." This particular view of executive function references earlier authors, such as Baddeley, who theorized that working memory and executive function operate in terms of neural network models. This concept of a neural network model can be explained as consisting of an input layer, a hidden layer, and an output layer. For Baddeley and others, the input layer took in the perceptual components of an object. Similarly, the hidden layer served to manipulate and decipher the components of the object. Finally, the output layer of the neural network model was understood as a final stage of thought, typically involving a conclusive action or, in the case of a memory model, the encoding of a long term memory. These neural network models were said to be operated by a central executive. However, this definition suggests the existence of a homunculus, an entity contained within the brain which selects and controls higher order thought processes. This explanation of executive function has proved ill-founded and slightly archaic, so that most recent research attempts to avoid its use. Neural network models also do not explain how executive function is accomplished, and thus make this approach particularly ineffective.

A second approach to executive function focuses on a structural representation of the cognitive process. This approach relies on neuropsychological batteries to reveal the areas of the brain involved. These tests serve to separate executive function into specific factors, such as inhibition and cognitive flexibility. Researchers associate the appropriate use of each factor with an individual's performance on a task. This definition of executive function falsely implies that experimenters understand the cognitive processes underlying each of these factors. On the contrary, they cannot agree on a name for each individual factor and its associated role in task performance. This disagreement demonstrates this lack of knowledge on the subject. For instance, Pennington (1997) describes the Wisconsin Card Sort Task as part of the "Set Shifting" factor, while Levin et al. (1991) describes the task as associated with "Perseveration and Disinhibition." In addition, one cannot demonstrate that the correlation between these factors and task performance can be attributed to a direct relation and does not include a variance due to shared methods. These weaknesses make this approach similarly ineffective in addressing executive function.

One final view of executive function is that suggested by Luria (1973). This approach considers executive function as a "functional construct," focusing on the results rather than the mechanism itself. Researchers make reference to the psychological processes involved, considering the individual's representation of the problem, the selection of a plan to solve that problem, and the implementation of this plan. In this approach, researchers do not seek to define executive function. Rather, they prepare the way for such definitions by examining well-established tests of executive function, clarifying the ways in which the various parts of executive function work together, and by avoiding understanding executive function as a homuncular ability.

This study does not concretely define executive function and the underlying psychological processes. Rather, it will follow the functional construct approach described above. This study will emphasize an understanding of executive function as the ability of children to maintain an appropriate problem-solving set, paying particular attention to their performance under specific circumstances (Pennington and Ozonoff, 1996). One way in which this study and several others accomplish this goal is through examining inflexibility. Inflexibility has historically been understood as an impediment to problem solving, dating as far back as the Gestalt theorists of the 1940s. These authors observed the rigidity with which subjects perceived and considered specific objects and situations, even after their approaches were no longer applicable. In contemporary research, psychologists study inflexibility under a rubric of perseveration. Perseveration serves to reveal underlying psychopathologies as well as damage to areas of the brain, particularly the prefrontal cortex. Patients with prefrontal damage often perseverate on the Wisconsin Card Sort Task, a psychological test often used to evaluate cognitive flexibility. In this task, participants are given four target cards, varying on the dimensions of color, shape, and number. Participants must sort a deck of test cards into four piles, matching each one with one of the given target cards. These participants are not informed of the rule; rather, they are told whether their match response is correct or incorrect. After a certain number of correct answers, the experimenter changes the rule, again without the knowledge of the participant. The participant must now discover what this new sorting rule and then apply it to the remaining test cards. Through this and other similar tasks, experimenters have found that inflexibility can occur both at the level of representation and at the level of response. Here, representation can be understood as an internal cognitive symbol that stands for an external reality. At the level of representation, researchers call this *representational inflexibility*, while at the level of response it is referred to as *failures of response control*.

In developmental literature, the different ages and different contexts in which perseveration occurs can be understood in terms of representational inflexibility and failures of response control. For example, in a task developed by Piaget, infants make what he calls the A-not-B error. The task involves hiding an object in location A and allowing the infant to search for it, which most children can successfully accomplish. However, when the experimenter moves the object to location B, hiding it so that most of the object is in plain view, the child will continue to search at location A for the object. Piaget would contest that the perseveration occurs due to errors at the level of representation, but a contemporary approach has suggested a failure of response control. This failure of response control describes the error as a product of the infant’s inability to inhibit the principal response. Further studies in executive function with older infants demonstrate that children develop these problem-solving skill sets according to a standard timeline. In a study done by DeLoache (1987), two-and-one-half and three year olds used a three dimensional model of a room to simulate the search for an object hidden in the room itself. When performing this task, two-and-a-half year olds perseverated on earlier trial hiding places, while three year olds could correctly locate the hidden object in its new position. According to DeLoache and colleagues, this task demonstrates age-related changes in representational flexibility. Two-and-one-half year olds only think of the room as a three dimensional object and cannot think of it as three year olds do, in terms of considering what it stands for.

Research regarding three and four year-olds further supports this idea of a developmental

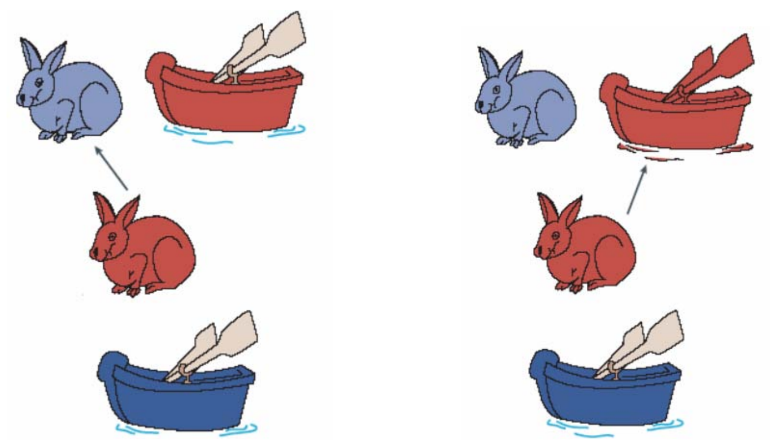

Figure 1

timeline for flexibility. Studies have demonstrated that three year olds have difficulty switching between incompatible perspectives on a specific object or set of objects. In other words, when a three year old is presented with conflicting information regarding the object, he or she will perseverate on the salient pieces of information and will be unable to substitute in the alternate set of facts. Four year olds, however, can analyze an object from these two separate viewpoints, moving easily from one representation to the next. Researchers have yet to determine how to best interpret these age-related changes in flexibility, but the use of a rubric for executive function in the study of these changes seems to be gaining more weight. One largely accepted method of studying executive function in relation to these increases in flexibility is the Dimensional Change Card Sort (DCCS). In this task, children are presented with cards that vary along two dimensions (e.g., shape and color). They are given two target cards (e.g., a blue rabbit and a red boat) and asked to sort a deck of ten cards varying upon the two previously mentioned dimensions (e.g., red rabbits and blue boats, Figure 1). Experimenters provide the rules by which children must sort these cards, asking them to sort the cards first by one dimension and then by the other. Traditionally, children sort five cards in the “pre-switch,” which describes the trials prior to the introduction of a new rule. Experimenters then inform children of this new rule, by which they must sort the five remaining cards in what is called the “post-switch.” Despite which dimension they are presented with first, three-to-four year olds perseverate along the first dimension in post-switch trials, demonstrating inflexibility in their representation of the cards. Even when reminded of the new rule for each trial, these children still perseverate. Four-to-five year olds, however, successfully utilize the new rule for the sorting of the remaining cards.

The DCCS has been proven reliable in its strong correlation with other measures of executive function, and the age-related changes seen in children’s performance on the task demonstrate that executive function undergoes rapid development between the ages of three and five. Several theories have been developed to explain these sudden changes. Morton and Munakata (2002) suggest a neural network model that explains the age-related changes on the DCCS in terms of accounts of memory. Specifically, these authors construct a model for the DCCS involving three layers of processing units: a layer of input units, a layer of hidden units, and a layer of output units. The layer of input units incorporates the test cards, the instructions for sorting these cards, and the relevant dimension for sorting. The hidden layer refers to a representation of the test cards and other pieces of information. The output layer corresponds to the target cards to which children match the test cards. Morton and Munakata discuss the effect of active versus latent memory traces on this model. Active memory traces are described under this model as sustained activity of particular processing units, while latent memory traces are described as being formed by changes in the strength of connections between processing units. In the brain, active memory traces are formed in the prefrontal cortex, while latent memory traces are formed in the posterior cortex. These latent memory traces are not accessible to other areas of the brain because of their implicit formation as changes in the strength of connections between processing units; however, these latent traces influence the activation of stimuli and, thus, affect the subsequent processing of these stimuli in other brain areas. Perseveration on the DCCS, as explained by this theory, occurs when an active memory trace for newly relevant information cannot compete for cognitive attention against a latent memory trace from the previously relevant input. In other words, if children must first sort according to color, this active memory trace will be maintained in the prefrontal cortex, and the increased strength of this connection will form a latent memory trace. Upon the post-switch, the active memory trace of the new relevant rule dimension, shape, must prove strong enough to overcome the latent memory traces connected to the previously relevant dimension, color. Activation strength of the new dimension in comparison to the latent memory trace depends on the development of the prefrontal cortex. A fully developed prefrontal cortex can effectively sustain activation of the relevant dimension, thus allowing for a switch in the representation of the target cards via the change in rule and dimension at the input processing level.

Other researchers have attributed the age-related differences in performance on the DCCS to the development of inhibition. According to a great deal of neuropsychological literature, the growth of inhibition parallels the growth of the prefrontal cortex. Thus, a more developed prefrontal cortex corresponds to a more effective use of the mental process of inhibition. One can see issues with inhibition at the level of response control, seeing a failure to suppress an overlearned response tendency. Here, overlearning refers to the repeated emphasis of a concept, so as to make a particular response or course of action become automatic. Carlson and Moses (2001), along with Perner and colleagues (1999), believe that three-to-four-year-olds acquire a prepotent response tendency or action schema during the preswitch of the DCCS. Carlson and Moses emphasize that perseveration does not occur due to problems with conflicting representations; rather, it occurs due to issues at the level of attention. In order to respond correctly to the rule switch in the post-switch of the DCCS, children must utilize executive inhibition. They must shift their attention by inhibiting the previously correct sorting rule in favor of a new sorting rule. Because three-to-four-years old are not as far along in their development of the prefrontal cortex, they will perform poorly on the post-switch of the DCCS. Four-to-five year olds, however, demonstrate the ability to shift attention to a new rule through their performance on the DCCS. This is due to a greater development of the prefrontal cortex in this age group. Thus, performance on the DCCS can be explained via inhibition and its development in connection with the prefrontal cortex.

One final set of theories of executive function in relation to the DCCS centers on the complexity of processing that children are capable of. Halford and colleagues hypothesized age-related differences in executive function stem from differences in experience. More experience supposedly correlates with a better understanding, which causes differences in executive function across ages. In addition, Halford hypothesized that the complexity of rules which children understand depends on their ability to process multiple items in parallel with one another. Research has introduced a different theory of increases in complexity called the Cognitive Control and Complexity Theory (CCC Theory). This particular theory understands these age-related changes in complexity in terms of a child's ability to formulate a hierarchical system of rules. The older and more experienced the child, the more complex the rule system they create. The CCC theory explains that children perseverate when they cannot integrate two incompatible representations into a larger rule system. Once the child formats a higher order rule to govern these two conflicting conceptions, they can use both in the same task. With regard to DCCS, three-to-four year olds cannot consider both color and shape when examining test cards until they have created a rule system that integrates the two dimensions. Four-to-five year olds, however, prove perfectly capable of using a higher order principle for organizing these dimensions.

The main concern of this study is the reliance of CCC theory, and several others, on the concept of dimensions. For the purposes of this study, one can define dimensions as perceptual categories, specifically color, shape, and number. Children who perform well on the DCCS have constructed a rule system that integrates several different dimensions. This rule system allows them to consider each dimension, selecting the one that fits the current setting conditions. In this study, we will replace these dimensions with more discrete categories used for labeling objects. Specifically, three-to-five year olds will evaluate pictures of cats and dogs by sorting them into the categories cats and dogs, and then into the categories of live animals ("pets") or stuffed animals ("toys.") If children continue to demonstrate differences across age groups in their ability to sort these images, this would demonstrate that complexity does not depend solely on dimensions but can be extended to other relevant categories used for sorting. 2603

EXPERIMENT 1

Methods

Participants. Participants in this study were three to four years of age (n= 28) and four to five years of age (n=36). Participants were recruited from daycares and preschools in the Greater Columbus Area. Recruitment and testing procedures were in accordance with a human subject protection protocol. Written parental consent and verbal consent from each participant was obtained.

Materials. Images of real cats, toy cats, real dogs, and toy dogs measuring 2.5 by 3 inches on each side were used. These images appeared on a laptop computer screen using the computer software program Superlab, with two target images in the top row and one test image in the bottom row.

Procedure. Testing took place in quiet locations in the preschools and daycares. All children were tested individually in 10 to 15 minute sessions using a laptop computer to administer the task via Superlab software. Once participants were seated in front of the computer and ready to begin, a set of rules was explained to them. The procedure followed the standard version of the Dimensional Change Card Sort as detailed by Frye, Zelazo, and Palfai (1995), with some slight modifications to allow for administration on a laptop computer. In the standard version, two images or cards chosen from the sorting categories (e.g., blue boat and red rabbit) are used as targets. The child is then presented with ten test cards (e.g., red boats and blue rabbits) one at a time and ask them to sort these cards into to piles on the target cards. The task begins with one rule (e.g., sort by shape) used to sort five of the test cards, and then switches to a second (e.g., sort by

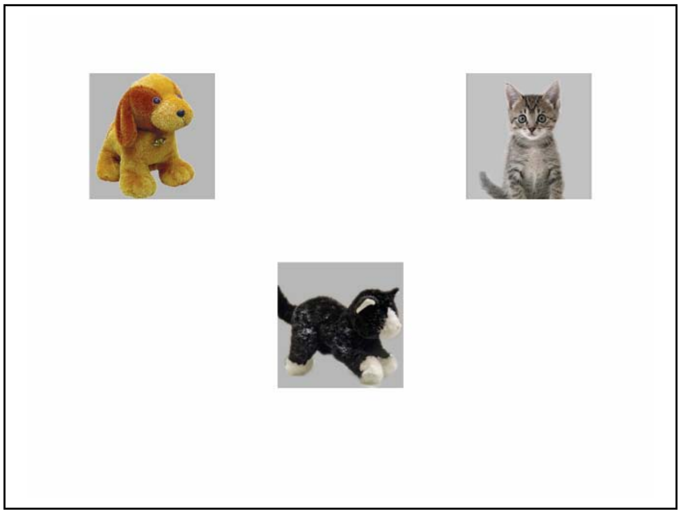

Figure 2

color) to sort the remaining five test cards. Experimenters repeat the sorting rule upon each new trial.

In this particular experiment, two example images were chosen from the two categories by which children would be sorting. For example, children were presented with a pet cat and a toy dog as target stimuli. These two target images appeared toward the upper corners of the computer screen, while the image to be sorted appeared in the middle toward the bottom of the screen (Figure 2). The first set of rules for sorting is introduced after the child was settled and ready to begin (e.g., toys go here, pets go here). The experiment included an orientation slide to illustrate the layout of each subsequent slide. After the first set of rules is introduced, two practice trials are administered. In these practice trials, the participant received an explanation of the rules. For the toy and pet rule, children were told: “A toy is not a real animal. So if you have a toy dog or a toy bear, those are not real animals. But a pet is a real animal, so if you have a pet bird or a pet hamster, those are real animals." Experimenters would then indicate the real cat, saying, "This is a pet because it is a real animal." Experimenters would then indicate the stuffed animal dog, saying, "This is a toy because it is not a real animal." After these rules had been established, the experimenter would let the child sort two images as practice, giving no feedback as to whether the response was correct or incorrect. Then the participant began sorting the test trial images. The child was reminded of the rule set and asked to respond as quickly as possible. The participant then began the five recorded experimental trials. For each of the five recorded trials, the experimenter repeated the sorting rule, saying, "Toys go here, and pets go here. Where does the picture on the bottom go?" or "Dogs go here, and cats go here. Where does the picture on the bottom go?" After the child had seen five slides in this fashion, the experimenter introduced the new set of rules (e.g., cats go here, dogs go here). In the same way as for the first set, the experimenter administered two practice trials, reminded the child of the rule set, asked the child to answer as quickly as possible, and then administered the five remaining recorded trials. Once again, the child was reminded of the sorting rule for each trial. In coding the child's responses, the experimenter pressed the 1 key when the child indicated the target stimulus on the left side of the screen, and he or she pressed the 0 key when the child indicated the stimulus on the right-hand side of the screen.

The experiment included two different conditions. The first condition had the cat and dog rule (i.e., cats go here, dogs go here) in the pre-switch and the toy and pet rule (i.e., toys go here, pets go here) in the post-switch. In other words, children were asked to sort by the cat and dog rule first, for the first five test stimuli, and then asked children to sort the remaining five test stimuli by the toy and pet rule. The second condition reversed the order of rules, with the toy and pet rule first in the pre-switch and the cat and dog rule following in the post-switch.

Results

In order to understand the predicted results for this study, one must first understand which data to consider. The original Dimensional Change Card Sort study (Frye, Zelazo, and Palfai, 1995) focused specifically on the mean score in the post-switch

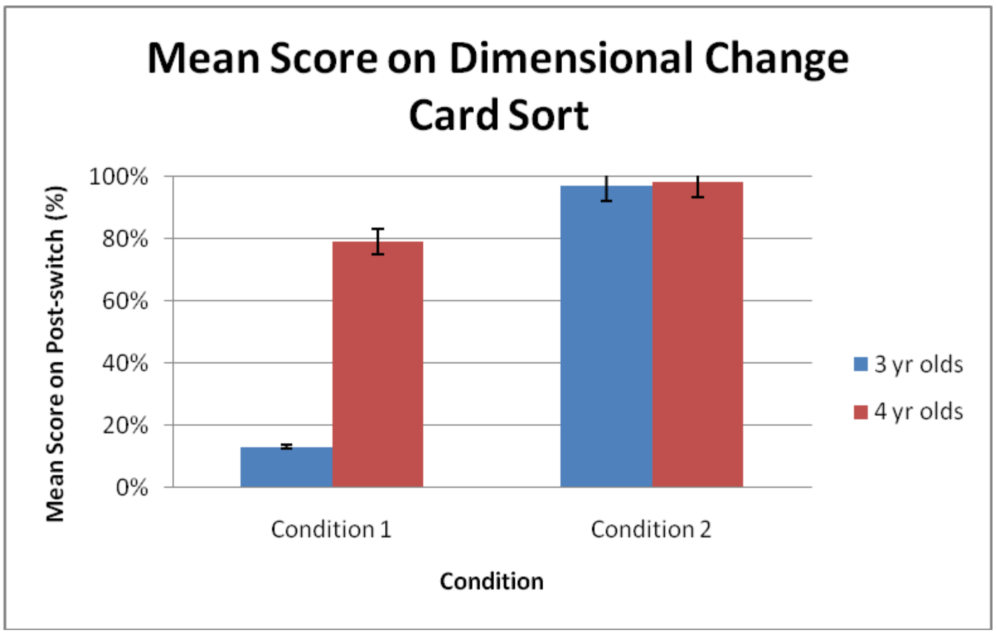

Figure 3

for each age group. Here, the score equates to the number of correct responses out of the total number of trials. For example, three out of five correctly sorted test images would earn a child a 60% score. A score of 80% correct was considered passing, while anything below this was considered failing. Frye's original study only considered the post-switch score for those children who obtained an 80% or better on the pre-switch trials. This approach functions to establish a child's ability to successfully perform the task. In the results from the original study, three year-olds scored significantly lower on the post-switch than four year-olds. In this our study, we predicted that one would see the same effects.

In experiment 1, one saw the predicted effects for the first condition. In other

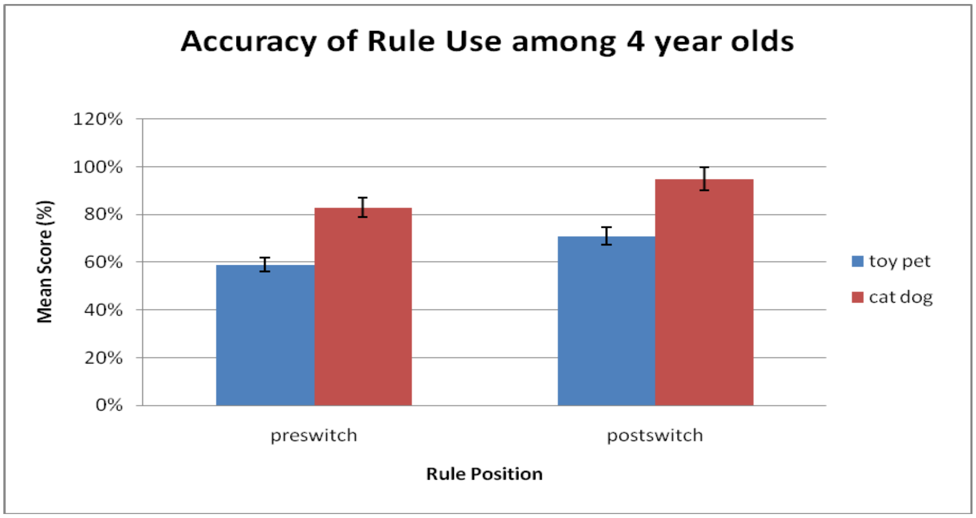

Figure 4

words, when the toy and pet rule was used in the post-switch, three year olds did worse in sorting test images than four year olds (Figure 3). This result was significant, $F(1, 28) = 25.38$, $p < 0.05$, suggesting that the age-related differences in executive function can apply to

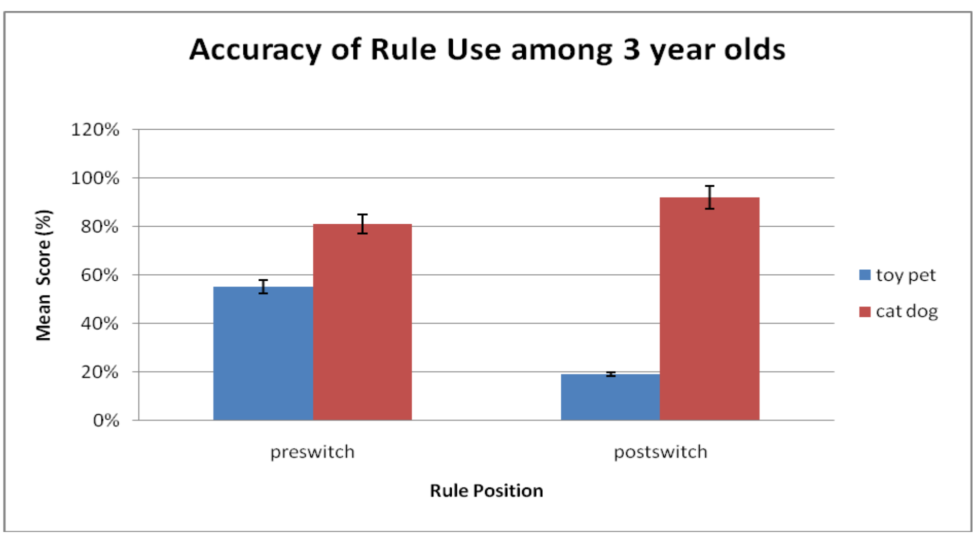

Figure 5

children's use of discrete categories as well as dimensions. However, in the second condition of experiment 1, the difference between three and four year olds was not significant. Both age groups did surprisingly well on the post-switch phase for condition. Furthermore, when examining all participants, half of the sample could not use the toy and pet rule properly when it occurred in the pre-switch. Four year olds, according to the original DCCS study, should understand the sorting concepts and perform the pre-switch trials without any notable problems. However, using the toy and pet rule in the pre-switch seemed to present additional problems outside the scope of the predictions. Thus, it became necessary to examine differences in use between rules within the age groups. Specifically, when examining three year olds' use of the toy and pet rule versus the cat and dog rule within the pre-switch (Figure 4), one saw a significant difference, $F(1, 28) = 7.111$, $p < 0.05$. Similarly, one saw a significant difference between rules for 3-year-olds in the post-switch, $F(1, 28) = 62.60$. From these results, one can see that, regardless of whether the rules were in pre-switch or post-switch, three year olds used the cat and dog rule much more effectively than the toy and pet rule. For four year olds, one saw similar effects (Figure 5), with differences in rule use being significant in the pre-switch, $F(1, 36) = 6.998$, $p < 0.05$, and in the post-switch, $F(1, 36) = 7.778$, p, 0.05. We formatted experiment 2 in hopes of elucidating these differences in rule use.

EXPERIMENT 2

Methods

Participants. Participants in this study were three to four years of age (n= 18) and four to five years of age (n=15). Participants were recruited from daycares and preschools in the Greater Columbus Area. Recruitment and testing procedures received ethical approval. Written parental consent was obtained.

Materials. Images of real cats, toy cats, real dogs, and toy dogs measuring 2.5 by 3 inches on each side were used. These images appeared on a laptop computer screen using the computer software program Superlab, with two target images in the top row and

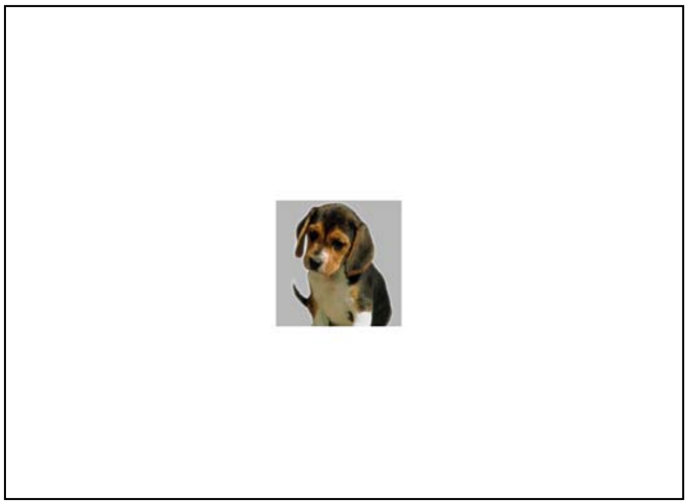

Figure 6

one test image in the bottom row, as in the first experiment. In addition, this experiment included slides with the same images that participants sorted in the middle of each page.

Procedure. The procedure for this experiment followed the procedure for experiment 1 with one additional task. After participants had sorted the ten test images by the preswitch and postswitch rules, they were presented with the same ten test stimuli (e.g., Figure 6) without any target images and asked to categorize these images as either toy or pet.

Results

Experiment 2 returned similar results in terms of age-related differences in post-switch performance for each condition. In considering performance on the familiarity task in conjunction with DCCS performance, one should examine participants' accuracy on the DCCS when using the toy pet rule against their accuracy on the familiarity task

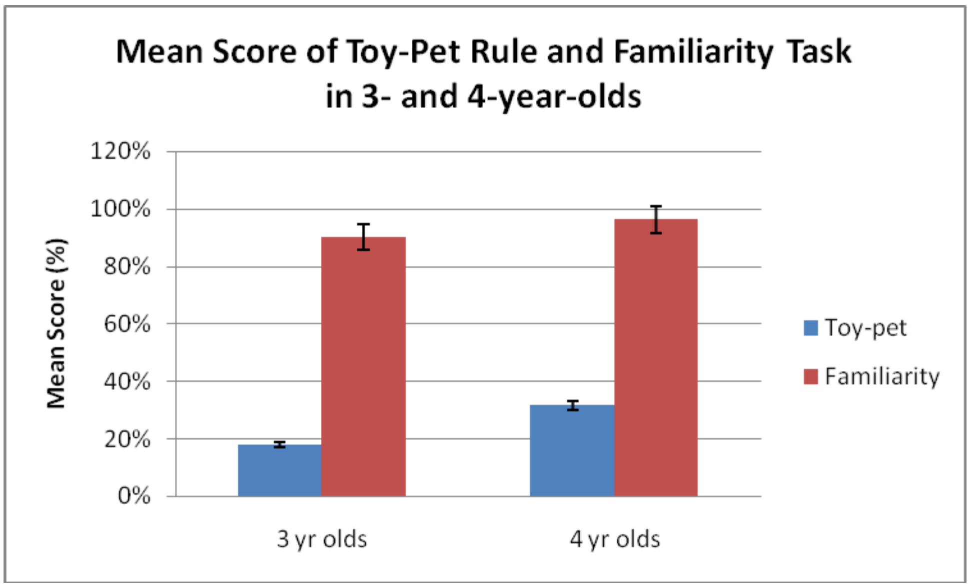

Figure 7

(Figure 7). For three year olds who failed to use the toy pet rule correctly, this comparison of accuracy scores proved significant, t (9) = 8.072. This suggested that, while three year olds understood the distinction between toys and pets, they were not able to apply this understanding to a sorting rule. This comparison in four year olds who failed to use the toy pet rule correctly also proved significant, t (6) = 5.280. This similarly demonstrates that four year olds understand the distinction between toys and pets but were unable to utilize this distinction for the purpose of sorting test images.

Discussion

In the first experiment, one only saw age-related differences in the first condition and not in the second condition. This meant that three year olds did worse than four year olds in sorting test images when the toy and pet rule was in the post-switch, but not when the cat and dog rule was in the post-switch. Upon further inspection, it was seen that a significant difference in the participants' ability to correctly use the cat and dog rule versus the toy and pet rule. This difference between rules was seen for both three year olds and four year olds, showing that one could not attribute this difference to age-related changes in the development of executive function. From these analyses, one can also see that this difference in accuracy scores for each rule exists regardless of pre-switch or post-switch. Furthermore, in the second condition, when the toy and pet rule was in the pre-switch, approximately half of the participants did not utilize this rule correctly and thus were not able to achieve a passing score. In response to this, one might attribute the inability of both three and four year olds to correctly use the toy and pet rule to a lack of understanding of the distinction between toys and pets. In order to demonstrate this claim as false, children were administered a familiarity task in experiment 2. High scores on this task demonstrate that preschoolers do understand the labels of toy and pet. However, their accuracy in sorting by these dimensions suggests that they cannot correctly apply this knowledge.

The next question one may ask is: what else could explain this difference between children's understanding of specific labels and their ability to apply these labels? First, one must understand categorization, specifically the increases in sophistication of labels that children can use. According to the work done by Eleanor Rosch (1976), humans categorize objects at two different levels: a basic and a superordinate level. The basic level of taxonomy focuses on the physical attributes of the object, and all other objects in the same category have several perceptual similarities. Objects at the superordinate level, however, do not share as many perceptual similarities. A superordinate category is one level more abstract than the basic level category, and objects are grouped into these classes because the weight of their similarities is greater than the weight of their distinctive features. For example, chair, lamp, and dresser all constitute basic level categories, and those objects that share perceptual similarities with each of these objects fall into that basic category. These objects also all fall into the superordinate category of furniture. While the similarities at this level might not be as striking, they outweigh the dissimilarities between these objects, and they do not share any perceptual similarities with objects in another superordinate category, such as vehicles.

In the case of this study, cat and dog can be considered basic level categories, while toy and pet would be considered superordinate level categories. Thus, in a hierarchical understanding, the basic level categories of cat and dog fall under the superordinate labels of toy and pet. Further research done by Marjorie Horton and Ellen Markman (1980) demonstrates that there may be developmental differences in the acquisition of hierarchical categorization abilities. She and her colleagues hypothesized that basic level categories are acquired first, followed by superordinate level categories. This may explain why participants in this study could easily label images as cat and dog but had more difficulty labeling them as toy and pet. In other words, these preschoolers have not yet developed the ability to consider the test images as members of both basic level groups and of superordinate level groups.

One other possible explanation for this difference in three and four year olds is Morton and Munakata's theory of latent versus active memory traces. This theory would suggest that, once the child had begun working with the cat and dog rule, this created very strong latent memory traces. In addition, the active memory trace of the toy and pet rule would not have been nearly strong enough to overcome the latent memory traces of the cat and dog rule. The strength of a child's experience with the labels of cat and dog versus toy and pet may have also influenced this difference in memory trace strength. Specifically, the labels of cat and dog can be considered overlearned in that children encounter these labels much more frequently and in direct comparison with one another when compared with the labels of toy and pet. The term "overlearned" also refers to the repeated teaching of a concept to a child even after he or she has demonstrated understanding of that concept. These overlearned labels of cat and dog would create stronger latent memory traces, which would make it even more difficult for the weak active memory trace of toy and pet to compete for more activation. Thus, when preschoolers already lack the executive control necessary to switch between activations of object representations, the effect of overlearned material serves to make this change even more difficult.

Conclusion

This study began with the objective of providing evidence against the assumption that dimensions govern a child's ability to create a hierarchical rule structure. By forming rules upon discrete categories instead of dimensions, experimenters hoped to see the same perseveration effects so as to prove this assumption of the CCC theory to be false. However, the results showed support for a different, previously unconsidered hypothesis: children perseverate on overlearned, basic-level labels rather than switching to superordinate level labels. This can be attributed to age-related differences in a child's ability to utilize these superordinate-level labels. The results demonstrate that three-to-four year olds understand the labels they were using. However, they are unable to inhibit the prepotent tendency to use a more familiar, basic-level term in favor of the superordinate-level term. Research by Horton and Markman (1980) has already demonstrated the possibility of age-related differences in children's ability to use superordinate rules. This study produces further evidence to support this claim. It also suggests that this inability to use superordinate labels before a certain age can be understood in terms of inflexibility. Participants in this task perseverated on the basic level labels, although they demonstrated knowledge of superordinate level labels. This demonstrates their inability to switch between a representation of target images in both basic and superordinate level categories. Further research must be conducted to ensure that three-to-four year olds are capable of categorizing using these superordinate labels of toy and pet. Also, the target images used for sorting test images must not have any conflict contained within them. In other words, one of the original test images was both a dog and a toy. Thus, children had trouble inhibiting the more strongly activated features of the image (i.e., its dog features) in favor of the less obvious superordinate toy features. Also, further research will demonstrate that, when unprompted, children will categorize the test images used in the original experiment as cats and dogs and almost never as toys and pets. Thus, this study clearly demonstrates a difference between the labels that a child understands and what they can apply to a rule system, and this may be influenced by the level of sophistication used to apply that label.

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